2.2.3 Economic prices for agricultural outputs and inputs

The economic prices of farm products such as rice and horticultural crops and of farm inputs such as fertilizers and agro-chemicals have been estimated on the basis of the projected international market prices forecasted for the year of 1995 by IBRD in the long term range in 1987 constant US dollar. The IBRD forecasted prices are adjusted to 1987 constant price level using the factor of 1.254 based on manufacturing unit value (MUV) index computed by IBRD. The domestic components are adjusted by SCF of 0.86.

2.2.4 Economic opportunity cost of farm labour

At present, most of the farm labour requirement are generally met by family labour. Seasonal labours required for transplanting and harvesting are mainly hired from neighbours at the rate of KShs.20 per man-day. In the MIS Scheme area, there is an abundant labour supply compared with its requirement. The estimated labour force in the MIS Scheme area is 10,938 adult-man equivalent as shown in Table VII-24. The present labour requirement for farm operations is, on the other, estimated to be 7,766 adult-man equivalent in total (see Table VII-24), which corresponds to about 70% of the total available labour force. Family labour is therefore shadow-priced at 70% of the present common labour rate as the surplus labour is considered underemployed. The adjusted conversion factor for family labour is therefore taken as 0.611 (0.71 x SCF), being wage rate of KShs.12.2/man-day.

2.2.5 Economic opportunity cost of common construction labour

During the rainy season, which is the period of peak demand for farm labour, the construction activities would slow down and labour would be less required. During the dry season, the Project would require more construction labour and such non-farm employment would be an attractive alternative for most of the local labours because of scarce farm work. This suggests that the economic opportunity cost of the construction labour may correspond to that of the hired farm labour.

The observations of the construction works in the vicinity of the Project area shows, however, local labourers require at least a 50% premium to be attracted to the construction work since it is harder than farming works. This has been reflected in the financial wage rate that is an average of KShs.50/man-day, but should not in determination of the corresponding economic opportunity cost. The economic opportunity cost of the common construction labour may be assumed to equal that of the hired farm labour of KShs.20/man-day. Related to the average financial wage rate of KShs.50/man-day, it would give a conversion factor of (20/50) x SCF = 0.344.

2.2.6 Construction conversion factor (CCF)

The individual financial costs for major Project components are split into four (4) categories of transfer payment, construction labour, non-traded costs and traded cost, for each of which an economic/financial conversion factor is applied. The construction conversion factor (CCF) that is the weighted average of the above component, is calculated as 0.84 for the dam and 0.80 for the irrigation works, as shown in Table XI-1.

2.3 Economic Benefits

The irrigation benefits are primarily derived from the increased crop production attributable to a stable irrigation water supplies. These benefits are estimated as the difference of the annual net crop production values under with and without Project conditions.

The net crop production value is defined as the difference between the gross production value and crop production cost. The net production values under future with and without Project conditions are summarized as follows (for details, see Table VII-32 in ANNEX-VII):

(Unit: KShs. million)

Description	Without Project	With Project	Increment
1. Gross production value			
(a) MIS	83.5	325.8	242.3
(b) Mutithi	1.7	144.2	142.5
Total	85.2	470.0	384.8
2. Total production cost			
(a) MIS	29.0	79.7	50.7
(b) Mutithi	1.0	35.5	34.5
Total	30.0	115.7	85.2
3. Net production value			
(a) MIS	54.4	246.1	191.6
(b) Mutithi	0.7	108.7	108.0
Total	55.2	354.8	299.6

It is assumed that the irrigation benefit will initially accrue from up-grading of the existing MIS Scheme in 4th year by 60% of the incremental benefits under single cropping and it will increase up to 100% of the benefit in 8th year. After completion of the dam construction, the incremental benefits will accrue from double cropping. The double cropping benefits will gradually increase during the build-up period of 5 years after completion of the dam from 60% in 9th year to 100% in 13th year, as shown in Table X-2.

2.4 Economic Cost

2.4.1 Capital cost

The Project cost broadly comprises (1) cost for preparatory works, (2) construction cost for Project facilities including contractor's overhead, profits and contract tax, (3) cost for land acquisition, compensation and resettlement, (4) administrative expenses, (5) procurement cost of agricultural machinery and O&M equipment, (6) expenses for engineering services, (7) physical contingencies and (8) price contingencies. All these costs are estimated on a financial basis as given in Table IX-3.

The financial costs are converted into the economic costs by applying the CCF for each of major components (see Table X-1):

(Unit: KShs. million)

	Cost Components	Financial Cost	CCF	Economic Cost
(1)	Dam & Reservoir	331.9	0.84	278.8
(2)	Irrigation Works	305.3	0.80	244.2
(3)	Farm Machinery	81.2	0.99	80.4
(4)	O&M Equipment	65.6	0.99	64.9
(5)	Farm Building	26.9	0.86	23.1
(6)	Land Acquisition	1.9	0.86	1.6
(7)	Administration	24.4	0.86	21.0
(8)	Engineering Services	81.1	0.90	72.9
(9)	Physical Contingencies	91.8	-	78.9
(10)	Price Contingencies	217.0	-	-
	Total	1,227.1	-	865.8

2.4.2 Annual operation and maintenance costs

The annual O&M costs estimated in ANNEX IX include the depreciation cost of O&M equipment and gates. In the economic evaluation, however, the depreciation is taken as the replacement cost. The depreciation cost of agricultural machinery estimated in the crop production costs is also taken as the replacement cost in the economic evaluation. The O&M cost after exclusion of the said depreciation cost is then converted into the economic cost using the respective CCF for each item:

(Unit: KShs. million)

Cost Components	Financial Cost	CCF/1	Economic Cost
(1) Salaries & Wages	14.0	0.67	9.4
(2) Office Expenses	0.4	0.77	0.3
(3) O&M for Project Facilities			
(a) Dam and reservoir	2.5	0.84	2.1
(b) Irrigation works	19.5	0.80	15.6
Total	36.4	-	27.4

Note: /1: See Table X-1

2.4.3 Replacement cost

The replacement costs estimated in in Section 6.6 of Chapter VI comprise (1) O&M equipment in every 10 years, (2) agricultural machinery in every 5 years, (3) farm buildings in every 20 years and (4) gates and attachments in every 25 years after Project implementation. These costs are converted into the economic cost applying a CCF of 0.99 for imported goods and SCF of 0.86 for farm buildings.

(Unit: KShs. million)

Description (KShs. million)	Useful Life (Year)	Financial Cost (KShs. million)	CCF	Economic Cost
(1) Agricultural Machinery	5	81.2	0.99	80.4
(2) O&M Equipment	10	65.6	0.99	64.9
(3) Farm Buildings	20	26.9	0.86	23.1
(4) Gates & Others	25	27.2	0.86	23.3
Total		200.9		191.7

2.5 Internal Rate of Return (IRR)

The economic rate of return is calculated on the basis of the flows of economic benefits and costs mentioned above (see Table X-3). The calculated result is:

IRR = 18.4%

2.6 Net Present Value

The net present value at the discount rate of 10% is also calculated on the same assumptions mentioned above:

NPV = KShs.682 million

2.7 Sensitivity Analysis

In order to evaluate the soundness of the Project against the possible changes in future economic conditions, sensitivity analysis are made for the following cases:

Case-1: 10% Project cost increase due to unforeseen geological and topographical conditions and unexpected increase of material cost

Case-2: 10% Project benefit decrease due to unexpected decrease in forecasted price of farm product and crop yield

Case-3: Two years overrun of the build-up period due to unexpected inefficiency in O&M management and agricultural extension services

Case-4: Two years overrun of construction period due to unexpected and unforeseen reasons

The effects of these changes in IRR and NPV (discount rate: 10%) are summarized as follows (Details are given in Table X-4):

Case	IRR (%)	NPV (KShs. million)
Case-1	17.0	598
Case-2	16.8	530
Case-3	17.6	626
Case-4	16.8	530

2.8 Results of Economic Evaluation

From the above results, the Project could be justified economically with IRR of 18.4% and NPV of KShs.682 million at the discount rate of 10%. The sensitivity analysis indicates that the economic feasibility of the Project is rather insensitive to the possible changes.

3. FINANCIAL ANALYSIS

3.1 Financial Cost

The financial cost estimated on the basis of the current prices as of mid 1987, is as follows (For details, see ANNEX-IX):

(Unit: KShs. million)

Foreign Currency	Local Currency	Total
758.7	468.4	1,227.1

In this estimate, the price contingencies of 7% per annum for local currency portion and 3% for foreign currency portion are included. The annual disbursement schedule for the required financial cost is given in ANNEX-IX.

3.2 Farm Budget Analysis and Payment Capacity

In order to evaluate the Project from the farmer' viewpoint, the farm budget analyses are made under future with and without the Project conditions as described in ANNEX-VII.

The payment capacity is recognized as the ability of the Project-benefited farmers to bear the expenses required for operation and maintenance of the Project facilities as well as for repayment of capital cost. The payment capacity is defined to be the difference of net disposable reserves under future with and without the Project conditions, which the farmers can actually earn from the Project after all the farm expenses and living costs are deducted from the gross farm income.

The payment capacity under the Project at the full operation stage is estimated as follows:

(Unit: KShs.)

Description	Farm Size (ha)	Disposable Reserve With Project	Disposable Reserve Without Project	Payment Capacity Per Farmer	Payment Capacity Per ha
(1) MIS	1.8	47,600	2,800	44,800	24,900
(2) Mutithi	3.2	76,200	500	75,700	23,700

The increased net disposable reserve would offer the better living conditions and welfare to the farmers and also the incentives for farm re-investment and further development, and the substantial payment capacity would make the farmers to make some payment for irrigation water.

3.3 Anticipated Project Revenue

The irrigation water charges which should cover the annual O&M expenses for the Project facilities and a part of the capital cost, would be collected from the Project-benefited farmers. The amount of irrigation water charge should be decided by the Government of Kenya, considering the payment capacity of the farmers and annual costs for operation and maintenance as well as the repayment for the capital cost. It should be noted that the payment capacity of the farmers would largely depend upon the prices of rice which is politically determined by the Government. The payment capacity of the farmers mentioned above is estimated on the basis of the present prices as of mid 1987.

3.4 Repayment of Project Cost

It is assumed that the initial investment required for the Project implementation will be arranged under the following conditions:

(1) For foreign currency portion, the capital is financed by bilateral or international organization with an interest of 3.0% per annum for a repayment period of 30 years including 10 year grace period.

(2) For local currency portion, the capital is arranged by the Government budget allocation with no repayment.

Based on the above conditions, the repayment schedule for the foreign currency portion is prepared as shown in Table X-5.

3.5 Result of Financial Evaluation

The Project will bring about a great improvement in farm budget, and give an incentives for further improvement of the irrigated land to the farmers. The farmers who will receive a large economic return, will spend their increased income for various purposes and the economic activities will thereby enhanced. Increased tax revenue will also be expected from such future economic circumstances. The Project could be justified from the farmers' viewpoint.

During the repayment period of 30 years for foreign loan, the annual average amount of the Government budget requirement for covering the loan repayment, loan interest, replacement cost and O&M costs is about KShs.98.1 million. This amount corresponds to KShs.10,300 per ha per annum, or 40% of the above-mentioned payment capacity per ha per annum. Most of the budget requirement for loan repayment and O&M expenses would be covered by the expected Project revenue in terms of water charge. The Project could be also justified from the financial viewpoint.

4. SOCIO-ECONOMIC IMPACTS

In addition to the direct benefits counted in the economic evaluation, various secondary and intangible benefits and/or favourable socio-economic impacts are expected from the implementation of the Project. Major socio-economic impacts are described hereunder:

(1) Increase of employment opportunity

Employment opportunity to the local people will be increased by the implementation of the Project, and a favourable impacts to the regional economy will be expected through the increased monetary movement. The employee will gain more experience, technical know-how, skillfulness in various working fields. These accumulations of working techniques would be applied to the future development in the region.

Irrigation will improve the present low land productivity and increase crop production in the Project area. The increased crop production will accelerate further development of agro-industries and marketing activities in the surrounding areas. It will also increase the employment opportunity.

(2) Foreign exchange saving

After completion of the Project, significant increase in rice production is expected. The marketable production would be about 100,000 tons of paddy. The increased production would largely reduce the import of rice and consequently contribute to the foreign exchange saving equivalent to around KShs.450 million per annum.

(3) Demonstration effects

The Mwea Irrigation Development Project has been given a leading role of pioneering the rice irrigation projects in Kenya. The successful implementation of the Project certainly leads to easier realization of other projects because of technical knowledge and skills to be accumulated through the Project implementation. With the completion of the Project, the farmers in the potential areas for irrigation development, as well as those in the Project area, will become familiar with double cropping of rice under modern irrigation practices and their incentives for irrigation practices will be much enhanced. In the succeeding projects, therefore, the build-up period possibly shortened.

(4) Increase of land value

The economic value of the land will surely increase with the Project implementation, particularly in the Mutithi extension area. It means that the value of land assets as a mortgage will become higher and the land

owners will have the larger monetary power when they will expand their business. It will also accelerate the economic activities in the region. During a certain period after completion of the Project, land transactions in the Project area will have to be controlled by the Government in order to achieve the social justice in the present system of land transactions.

(5) Improvement of local transportation

The local transportation will be much improved by the construction of the operation and maintenance roads along the irrigation canals as well as the link canals and headrace. The expanded road system will not only enhance the economic activities but also contribute to inter-regional accessibility and communication.

(6) Mitigation of flood damages

The downstream area in the Thiba part is sometimes flooded in the rainy season. Although the proposed plan does not include the flood control in its purpose, operation of the reservoir will have incidental effects on flood control through reduction in flood frequency and peak discharge.

(7) Improvement of farm product

The quality of rice will be much improved through sufficient irrigation water supplies which enable the crop damages minimize and assure the full and uniform maturing of rice. Such improved quality would increase the marketability of the product.

(8) Improvement of rural water supplies

The rehabilitation of the existing canal system will improve the situation of water shortage through year-round supply of the fresh water in sufficient quantity from the irrigation canals. New construction of irrigation canals in the Mutithi area will provide the farmers with easy access to domestic water.

(9) Potential uses of the reservoir

After creation of the reservoir, the fish production will become possible. It will provide the local people with new business opportunity. The rapid increase of rural population around the Project area will cause a significant increase in the use of reservoir for recreational purposes like fishing and boating. Provision should be made to obtain the maximum recreational benefits from the completed reservoir.

Table X-1 Structure of Financial and Economic Cost (in percent)

Cost Component	Financial Cost				Economic Cost				Weighted Conversion Factor
	Local Cost			Foreign Cost	Local Cost			Foreign Cost	
	Transfer Payment	Unskilled Labour	Others		Transfer Payment	Unskilled Labour	Others		
Capital Cost									
1. Dam & Reservoir	10	6	13	71	-	2	11	71	0.84
2. Irrigation Works	9	12	21	58	-	4	18	58	0.80
3. Office & Quarters	9	15	76	-	-	5	65	-	0.70
4. Land Acquisition	-	-	100	-	-	-	86	-	0.86
5. Agricultural Machinery and O&M Equipment	-	-	10	90	-	-	9	90	0.99
6. Administration	-	-	100	-	-	-	86	-	0.86
7. Engineering Services	4	-	35	60	-	-	30	60	0.90
8. On-Farm Development	9	15	20	56	-	5	17	56	0.78
O&M Cost									
1. Salaries & Wages	10	20	70	-	-	7	60	-	0.67
2. Office Expenses	10	-	90	-	-	-	77	-	0.77
3. O&M Expenses									
a. Dam	9	5	86	-	-	2	74	-	0.76
b. Irrigation	9	10	81	-	-	3	70	-	0.73

Note: The conversion factor for the transfer payments like taxes and duties is 0, compared to 0.344 for unskilled construction labour, 0.86 for other local costs and 1.00 for foreign costs.
Last column indicates the specific economic conversion factor for each cost component.

Table X-2 Annual Incremental Benefit

Year	Irrigation Benefit (KShs.million)
1st	0
2nd	0
3rd	0
4th	0
5th	25.3
6th	30.3
7th	159.9
8th	189.9
9th	219.9
10th	249.8
11th	274.7
12th	299.6
13th	299.6
.	.
.	.
50th	299.6

Table X-3 Cost and Benefit Stream (Original Case)

(Unit:Million Kshs.)

Year In Order	Year (Tentative)	Economic Cost				Agricultural Benefit
		Construction Cost	Replacement Cost	O&M Cost	Total	
1.	1988	14.9			14.9	
2.	1989	130.8			130.8	
3.	1990	51.9			51.9	
4.	1991	195.9			195.9	
5.	1992	194.4		10.6	205.0	25.3
6.	1993	277.9		12.4	290.3	30.3
7.	1994			20.0	20.0	159.9
8.	1995			22.7	22.7	189.9
9.	1996			25.5	25.5	219.9
10.	1997		51.1	26.4	77.5	249.8
11.	1998			27.4	27.4	274.7
12.	1999		29.2	27.4	56.6	299.6
13.	2000			27.4	27.4	299.6
14.	2001			27.4	27.4	299.6
15.	2002		86.8	27.4	114.2	299.6
16.	2003			27.4	27.4	299.6
17.	2004		58.4	27.4	85.8	299.6
18.	2005			27.4	27.4	299.6
19.	2006			27.4	27.4	299.6
20.	2007		51.1	27.4	78.5	299.6
21.	2008			27.4	27.4	299.6
22.	2009		29.2	27.4	56.6	299.6
23.	2010			27.4	27.4	299.6
24.	2011			27.4	27.4	299.6
25.	2012		100.4	27.4	127.8	299.6
26.	2013			27.4	27.4	299.6
27.	2014		67.9	27.4	95.3	299.6
28.	2015			27.4	27.4	299.6
29.	2016			27.4	27.4	299.6
30.	2017		52.7	27.4	80.1	299.6
31.	2018			27.4	27.4	299.6
32.	2019		50.9	27.4	78.3	299.6
33.	2020			27.4	27.4	299.6
34.	2021			27.4	27.4	299.6
35.	2022		86.8	27.4	114.2	299.6
36.	2023			27.4	27.4	299.6
37.	2024		58.4	27.4	85.8	299.6
38.	2025			27.4	27.4	299.6
39.	2026			27.4	27.4	299.6
40.	2027		51.1	27.4	78.5	299.6
41.	2028			27.4	27.4	299.6
42.	2029		29.2	27.4	56.6	299.6
43.	2030			27.4	27.4	299.6
44.	2031			27.4	27.4	299.6
45.	2032		100.4	27.4	127.8	299.6
46.	2033			27.4	27.4	299.6
47.	2034		67.9	27.4	95.3	299.6
48.	2035			27.4	27.4	299.6
49.	2036			27.4	27.4	299.6
50.	2037		51.1	27.4	78.5	299.6

I.R.R= 18.4%

Table X-4 Cost and Benefit Stream for Sensitivity Analysis(1/2)

Case-1 : 10% Project Cost Increase

(Unit:Million Kshs.)

Year In Order	Year (Tentative)	Economic Cost: Construction Cost	Replacement Cost	O&M Cost	Total	Agricultural Benefit
1.	1988	16.4			16.4	
2.	1989	143.9			143.9	
3.	1990	57.1			57.1	
4.	1991	215.5			215.5	
5.	1992	213.8		10.6	224.4	25.3
6.	1993	305.7		12.4	318.1	30.3
7.	1994			20.0	20.0	159.9
8.	1995			22.7	22.7	189.9
9.	1996			25.5	25.5	219.9
10.	1997		51.1	26.4	77.5	249.8
11.	1998			27.4	27.4	274.7
12.	1999		29.2	27.4	56.6	299.6
13.	2000			27.4	27.4	269.6
14.	2001			27.4	27.4	269.6
15.	2002		86.8	27.4	114.2	269.6
16.	2003			27.4	27.4	269.6
17.	2004		58.4	27.4	85.8	269.6
18.	2005			27.4	27.4	269.6
19.	2006			27.4	27.4	269.6
20.	2007		51.1	27.4	78.5	269.6
21.	2008			27.4	27.4	269.6
22.	2009		29.2	27.4	56.6	269.6
23.	2010			27.4	27.4	269.6
24.	2011			27.4	27.4	269.6
25.	2012		100.4	27.4	127.8	269.6
26.	2013			27.4	27.4	269.6
27.	2014		67.9	27.4	95.3	269.6
28.	2015			27.4	27.4	269.6
29.	2016			27.4	27.4	269.6
30.	2017		52.7	27.4	80.1	269.6
31.	2018			27.4	27.4	269.6
32.	2019		50.9	27.4	78.3	269.6
33.	2020			27.4	27.4	269.6
34.	2021			27.4	27.4	269.6
35.	2022		86.8	27.4	114.2	269.6
36.	2023			27.4	27.4	269.6
37.	2024		58.4	27.4	85.8	269.6
38.	2025			27.4	27.4	269.6
39.	2026			27.4	27.4	269.6
40.	2027		51.1	27.4	78.5	269.6
41.	2028			27.4	27.4	269.6
42.	2029		29.2	27.4	56.6	269.6
43.	2030			27.4	27.4	269.6
44.	2031			27.4	27.4	269.6
45.	2032		100.4	27.4	127.8	269.6
46.	2033			27.4	27.4	269.6
47.	2034		67.9	27.4	95.3	269.6
48.	2035			27.4	27.4	269.6
49.	2036			27.4	27.4	269.6
50.	2037		51.1	27.4	78.5	269.6

I.R.R= 17.0%

Case-2 : 10% Project Benefit Decrease

(Unit:Million Kshs.)

Year In Order	Year (Tentative)	Economic Cost: Construction Cost	Replacement Cost	O&M Cost	Total	Agricultural Benefit
1.	1988	14.9			14.9	
2.	1989	130.8			130.8	
3.	1990	51.9			51.9	
4.	1991	195.9			195.9	
5.	1992	194.4		10.6	205.0	22.8
6.	1993	277.9		12.4	290.3	27.3
7.	1994			20.0	20.0	143.9
8.	1995			22.7	22.7	170.9
9.	1996			25.5	25.5	197.9
10.	1997		51.1	26.4	77.5	226.8
11.	1998			27.4	27.4	247.2
12.	1999		29.2	27.4	56.6	269.6
13.	2000			27.4	27.4	269.6
14.	2001			27.4	27.4	269.6
15.	2002		86.8	27.4	114.2	269.6
16.	2003			27.4	27.4	269.6
17.	2004		58.4	27.4	85.8	269.6
18.	2005			27.4	27.4	269.6
19.	2006			27.4	27.4	269.6
20.	2007		51.1	27.4	78.5	269.6
21.	2008			27.4	27.4	269.6
22.	2009		29.2	27.4	56.6	269.6
23.	2010			27.4	27.4	269.6
24.	2011			27.4	27.4	269.6
25.	2012		100.4	27.4	127.8	269.6
26.	2013			27.4	27.4	269.6
27.	2014		67.9	27.4	95.3	269.6
28.	2015			27.4	27.4	269.6
29.	2016			27.4	27.4	269.6
30.	2017		52.7	27.4	80.1	269.6
31.	2018			27.4	27.4	269.6
32.	2019		50.9	27.4	78.3	269.6
33.	2020			27.4	27.4	269.6
34.	2021			27.4	27.4	269.6
35.	2022		86.8	27.4	114.2	269.6
36.	2023			27.4	27.4	269.6
37.	2024		58.4	27.4	85.8	269.6
38.	2025			27.4	27.4	269.6
39.	2026			27.4	27.4	269.6
40.	2027		51.1	27.4	78.5	269.6
41.	2028			27.4	27.4	269.6
42.	2029		29.2	27.4	56.6	269.6
43.	2030			27.4	27.4	269.6
44.	2031			27.4	27.4	269.6
45.	2032		100.4	27.4	127.8	269.6
46.	2033			27.4	27.4	269.6
47.	2034		67.9	27.4	95.3	269.6
48.	2035			27.4	27.4	269.6
49.	2036			27.4	27.4	269.6
50.	2037		51.1	27.4	78.5	269.6

I.R.R= 16.8%

Table X-4 Cost and Benefit Stream for Sensitivity Analysis(2/2)

Case-3 : Two Years Overrun of the Build-up Period

(Unit:Million Ksha.)

Year In Order	Year (Tentative)	Economic Cost: Construction Cost	Replacement Cost	O&M Cost	Total	Agricultural Benefit
1.	1988	14.9			14.9	
2.	1989	130.8			130.8	
3.	1990	51.9			51.9	
4.	1991	195.9			195.9	
5.	1992	194.4		10.6	205.0	25.3
6.	1993	277.9		12.4	290.3	28.8
7.	1994			20.0	20.0	157.0
8.	1995			22.7	22.7	178.3
9.	1996			25.5	25.5	199.5
10.	1997		51.1	26.4	77.5	220.8
11.	1998			27.4	27.4	242.1
12.	1999		29.2	27.4	56.6	263.4
13.	2000			27.4	27.4	281.2
14.	2001			27.4	27.4	299.6
15.	2002		86.8	27.4	114.2	299.6
16.	2003			27.4	27.4	299.6
17.	2004		58.4	27.4	85.8	299.6
18.	2005			27.4	27.4	299.6
19.	2006			27.4	27.4	299.6
20.	2007		51.1	27.4	78.5	299.6
21.	2008			27.4	27.4	299.6
22.	2009		29.2	27.4	56.6	299.6
23.	2010			27.4	27.4	299.6
24.	2011			27.4	27.4	299.6
25.	2012		100.4	27.4	127.8	299.6
26.	2013			27.4	27.4	299.6
27.	2014		67.9	27.4	95.3	299.6
28.	2015			27.4	27.4	299.6
29.	2016			27.4	27.4	299.6
30.	2017		52.7	27.4	80.1	299.6
31.	2018			27.4	27.4	299.6
32.	2019		50.9	27.4	78.3	299.6
33.	2020			27.4	27.4	299.6
34.	2021			27.4	27.4	299.6
35.	2022		86.8	27.4	114.2	299.6
36.	2023			27.4	27.4	299.6
37.	2024		58.4	27.4	85.8	299.6
38.	2025			27.4	27.4	299.6
39.	2026			27.4	27.4	299.6
40.	2027		51.1	27.4	78.5	299.6
41.	2028			27.4	27.4	299.6
42.	2029		29.2	27.4	56.6	299.6
43.	2030			27.4	27.4	299.6
44.	2031			27.4	27.4	299.6
45.	2032		100.4	27.4	127.8	299.6
46.	2033			27.4	27.4	299.6
47.	2034		67.9	27.4	95.3	299.6
48.	2035			27.4	27.4	299.6
49.	2036			27.4	27.4	299.6
50.	2037		51.1	27.4	78.5	299.6

I.R.R=17.6%

Case-4 : Two Years Overrun of Construction Period

(Unit:Million Ksha.)

Year In Order	Year (Tentative)	Economic Cost: Construction Cost	Replacement Cost	O&M Cost	Total	Agricultural Benefit
1.	1988	14.9			14.9	
2.	1989	130.8			130.8	
3.	1990	51.9			51.9	
4.	1991	122.5			122.5	
5.	1992	0.0		10.6	10.6	25.3
6.	1993	73.4		12.4	85.8	30.3
7.	1994	194.4		20.0	214.4	35.3
8.	1995	277.9		22.7	300.6	40.4
9.	1996			25.5	25.5	170.1
10.	1997		51.1	26.4	77.5	200.0
11.	1998			27.4	27.4	224.9
12.	1999		29.2	27.4	56.6	249.8
13.	2000			27.4	27.4	274.7
14.	2001			27.4	27.4	299.6
15.	2002		86.8	27.4	114.2	299.6
16.	2003			27.4	27.4	299.6
17.	2004		58.4	27.4	85.8	299.6
18.	2005			27.4	27.4	299.6
19.	2006			27.4	27.4	299.6
20.	2007		51.1	27.4	78.5	299.6
21.	2008			27.4	27.4	299.6
22.	2009		29.2	27.4	56.6	299.6
23.	2010			27.4	27.4	299.6
24.	2011			27.4	27.4	299.6
25.	2012		100.4	27.4	127.8	299.6
26.	2013			27.4	27.4	299.6
27.	2014		67.9	27.4	95.3	299.6
28.	2015			27.4	27.4	299.6
29.	2016			27.4	27.4	299.6
30.	2017		52.7	27.4	80.1	299.6
31.	2018			27.4	27.4	299.6
32.	2019		50.9	27.4	78.3	299.6
33.	2020			27.4	27.4	299.6
34.	2021			27.4	27.4	299.6
35.	2022		86.8	27.4	114.2	299.6
36.	2023			27.4	27.4	299.6
37.	2024		58.4	27.4	85.8	299.6
38.	2025			27.4	27.4	299.6
39.	2026			27.4	27.4	299.6
40.	2027		51.1	27.4	78.5	299.6
41.	2028			27.4	27.4	299.6
42.	2029		29.2	27.4	56.6	299.6
43.	2030			27.4	27.4	299.6
44.	2031			27.4	27.4	299.6
45.	2032		100.4	27.4	127.8	299.6
46.	2033			27.4	27.4	299.6
47.	2034		67.9	27.4	95.3	299.6
48.	2035			27.4	27.4	299.6
49.	2036			27.4	27.4	299.6
50.	2037		51.1	27.4	78.5	299.6

I.R.R=16.7%

Table X-5 Financial Cash Flow Statement

(Unit :kshs. million)

Year	Year in Order	Cash Outflow: Project Cost	O &M Cost	Replacement Cost	Loan Interest	Loan Repayment	Total Outflow(A)	Cash Inflow: Foreign Loan	Government Budget	Government Subsidy	Water Charge	Total Inflow(B)	Balance (B)-(A)	Accumulated Loan
1987	1	17.3	0.0	0.0	0.3	0.0	17.6	8.9	8.4	0.3	0.0	17.6	0.0	8.9
1988	2	162.8	0.0	0.0	3.5	0.0	166.3	106.2	56.6	3.5	0.0	166.3	0.0	115.1
1989	3	66.2	0.0	0.0	4.6	0.0	70.8	38.1	28.1	4.6	0.0	70.8	0.0	153.2
1990	4	274.3	0.0	0.0	9.5	0.0	283.8	160.7	113.6	9.5	0.0	283.8	0.0	313.9
1991	5	291.4	20.6	0.0	14.8	0.0	326.8	177.7	113.7	35.4	0.0	326.8	0.0	491.6
1992	6	415.1	24.0	0.0	22.8	0.0	461.9	267.1	148.0	46.8	0.0	461.9	0.0	758.7
1993	7	0.0	38.5	0.0	22.8	0.0	61.3	0.0	0.0	61.3	0.0	61.3	0.0	758.7
1994	8	0.0	43.9	0.0	22.8	0.0	66.7	0.0	0.0	66.7	0.0	66.7	0.0	758.7
1995	9	0.0	49.1	0.0	22.8	0.0	71.9	0.0	0.0	71.9	0.0	71.9	0.0	758.7
1996	10	0.0	51.0	51.7	22.8	0.0	125.5	0.0	0.0	125.5	0.0	125.5	0.0	758.7
1997	11	0.0	52.8	0.0	21.7	37.9	112.4	0.0	0.0	112.4	0.0	112.4	0.0	720.8
1998	12	0.0	52.8	29.5	20.5	37.9	140.8	0.0	0.0	140.8	0.0	140.8	0.0	682.8
1999	13	0.0	52.8	0.0	19.4	37.9	110.1	0.0	0.0	110.1	0.0	110.1	0.0	644.9
2000	14	0.0	52.8	0.0	18.3	37.9	109.0	0.0	0.0	109.0	0.0	109.0	0.0	607.0
2001	15	0.0	52.8	87.8	17.1	37.9	195.7	0.0	0.0	195.7	0.0	195.7	0.0	569.0
2002	16	0.0	52.8	0.0	16.0	37.9	106.7	0.0	0.0	106.7	0.0	106.7	0.0	531.1
2003	17	0.0	52.8	59.0	14.8	37.9	164.6	0.0	0.0	164.6	0.0	164.6	0.0	493.2
2004	18	0.0	52.8	0.0	13.7	37.9	104.4	0.0	0.0	104.4	0.0	104.4	0.0	455.2
2005	19	0.0	52.8	0.0	12.6	37.9	103.3	0.0	0.0	103.3	0.0	103.3	0.0	417.3
2006	20	0.0	52.8	51.7	11.4	37.9	153.9	0.0	0.0	153.9	0.0	153.9	0.0	379.4
2007	21	0.0	52.8	0.0	10.3	37.9	101.0	0.0	0.0	101.0	0.0	101.0	0.0	341.4
2008	22	0.0	52.8	29.5	9.2	37.9	129.4	0.0	0.0	129.4	0.0	129.4	0.0	303.5
2009	23	0.0	52.8	0.0	8.0	37.9	98.7	0.0	0.0	98.7	0.0	98.7	0.0	265.5
2010	24	0.0	52.8	0.0	6.9	37.9	97.6	0.0	0.0	97.6	0.0	97.6	0.0	227.6
2011	25	0.0	52.8	103.7	5.7	37.9	200.2	0.0	0.0	200.2	0.0	200.2	0.0	189.7
2012	26	0.0	52.8	0.0	4.6	37.9	95.3	0.0	0.0	95.3	0.0	95.3	0.0	151.7
2013	27	0.0	52.8	70.1	3.5	37.9	164.3	0.0	0.0	164.3	0.0	164.3	0.0	113.8
2014	28	0.0	52.8	0.0	2.3	37.9	93.1	0.0	0.0	93.1	0.0	93.1	0.0	75.9
2015	29	0.0	52.8	53.5	1.2	37.9	145.4	0.0	0.0	145.4	0.0	145.4	0.0	37.9
2016	30	0.0	52.8	0.0	0.1	37.9	90.8	0.0	0.0	90.8	0.0	90.8	0.0	0.0
Total		1,227.1	1,283.1	536.5	363.9	758.7	4,169.3	758.7	468.4	2,942.2	0.0	4,169.3	0.0	

Foreign Loan: Annual interest of 3.0% for repayment period of 30 years including 10-year grace period.

ANNEX - XI

PILOT FARM

ANNEX - XI

PILOT FARM

TABLE OF CONTENTS

LIST OF FIGURES

1. OBJECTIVES OF PILOT FARM

In the existing MIS, the double cropping of paddy has not been practiced since cultivation started in 1954. Although MIS has made a series of double cropping trials, all of the trials have ended in total failure. The reasons for the failure in double cropping trials are manifold; however, the decisive factors are considered as follows:

(1) Lack of suitable variety for double cropping

The varieties of the paddy cultivated in Kenya at present are those which growing period is 150-160 days. The double cropping with those varieties of paddy makes the harvest in April-May during the long rains season which causes much post-harvest losses, or it makes the panicle formation stage in June-July which causes serious unit yield reduction by low temperature.

The key factor for successful introduction of double cropping of paddy is therefore to select the rice varieties with the growth period of 110-120 days which are also tolerant to low temperature and insects/diseases and furthermore have good cooking quality.

(2) Deterioration of irrigation facilities, in sufficient supply of irrigation water, and lack of proper water management system

The existing irrigation facilities in MIS have been deteriorated due to lack of proper maintenance. The intake water at the headworks is usually less than requirement in the field. The shortage of irrigation water is almost normal condition in MIS. Furthermore, lack of the water management system based on sufficient technical background, also results in various difficulties for proper water supplies to every part of the paddy field. It is therefore considered that in parallel with the rehabilitation works, the most applicable water management system should be established through technical studies on water management method and system.

(3) Insufficient mobility in farming operation

MIS has only 26 workable tractors of 60 PS class at present, and for ploughing 5,860 ha of paddy (rotavation), it takes about 150 days to complete. Rotavation will necessarily have to be completed within about 50 days for successful introduction of double cropping. Furthermore, the present processing capacity of the existing reception centres is rather small in comparison with the expected daily harvest. The period for receiving and drying the harvested paddy will become shorter when double cropping of paddy is introduced. This also makes double cropping of paddy difficult.

Large scale trials on the double cropping of rice were made four times in the past by the order of the Government of Kenya. None of the trials however succeeded mainly due to the above reasons. The success in the double cropping of rice has long been desired by the Government as well as the MIS farmers.

For successful introduction of double cropping of rice, the above constraints will have to be solved. The Project will certainly give the way to solve some of the technical constraints such as deteriorated irrigation facilities, shortage of irrigation water and unsatisfactory mobility in farming operation. However, some other constraints will still remain particularily in the fields of agronomy and water management. With this in view, it is recomended that a pilot farm be established in the Project area. The pilot farm will have the following objectives.

(a) selection of rice varieties suitable for long rains crop and demonstration of double cropping to the farmers,

(b) field trials on farm machinery and equipment,

(c) field trials and demonstration on irrigated horticultural crops cultivation in the red soils,

(d) field trials on irrigation practices and water management both for rice and horticultural crops, and

(e) seed multiplication

2. PROPOSED SITE FOR PILOT FARM

(1) Location

The proposed pilot farm site is located near Unit M-9 of the existing Mwea Section in MIS with a total area of about 100 ha. The proposed site is mostly grassland at present. The site location is indicated in Fig. XI-1. The proposed site is selected, taking the following into account:

- Favourable road condition for access to the site,
- Easy availability of irrigation water,
- Availability of large virgin land of about 50 ha,
- Availability of both red soils and black cotton soils in one place, and
- Area near the Mutithi extension area.

The selected site meets all the above conditions. However, the proposed site for the pilot farm is privately owned. Preliminary enquiries among the land owners at the proposed site are still being made by NIB.

(2) Present condition of the proposed pilot farm site

The proposed site consists of flat lowland (65 ha) where black cotton soils are developed and hilly land (35 ha) covered with red soils. The present conditions of both areas are as follows:

Area	Topography	Soil	Land Use
Flat lowland	Slope : 1/200 Elevation : 1,188-1,190 m	Black cotton soils	Grassland
Hilly land	Slope : 1/80 Elevation : 1,189-1,195 m	Red and brownish red soils	Upland field

3. OUTLINE OF PILOT FARM PLAN

(1) Scale of the pilot farm

The following will be minimum requirement for pilot farm operation:

Farm	(ha)
1. Irrigated paddy field	30
2. Irrigated horticultural crops field	10
3. Experimental farm	5
Buildings and related facilities	5

(2) Facilities plan

(a) Irrigation facilities

The irrigation water will be taken trough a turnout to be newly constructed in the existing Thiba main canal at water level of 1,196 m.

The main feeder canal will directly take water from the turnout and convey to the fields. The highest irrigable area will be 1,194 m. The general layout is shown in Fig. XI-2.

(b) Drainage facilities

The existing natural drain flowing into the upstream end of the existing Kiruara main drain at the northwest end of unit M-9 in MIS will be improved as the main collector drain of the pilot farm.

(c) Buildings and related facilities

The following buildings and related facilities will be provided:

1. Pilot farm main office
2. Warehouse for equipments and tools
3. Drying facilities and rice mill
4. Agricultural machinery, garage and workshop
5. Experimental facilities including laboratory equipment
6. Meteorological observation facilities
7. Warehouse for spare parts,fertilizer, pesticide and others

4. PRELIMINARY DESIGN OF PILOT FARM

(1) Irrigation canals and related structures

The irrigation system in the pilot farm comprises one (1) main feeder canal, three (3) branch feeder canals and eleven (11) feeder canals. The required structures related to the above canals would be a turnout in Thiba main canal, offtakes in the main feeder canal for diversion of water to branch feeder canals, offtakes in branch feeder canals for distribution of water to feeder canals, checks and culverts.

The general features of the proposed irrigation facilities are shown below:

Turnout	Type	:	double orifice, pipe conduit
	Intake W.L	:	1,196 m
	Intake discharge	:	0.07 m^3/s
	Gate	:	W 0.3 m x H 0.3 m

Canal	Length	Bed Width Width	Canal Height	Remarks
	(m)	(m)	(m)	
Main feeder canal	1,650	0.30	0.50	Concrete lining
Branch feeder canal No. 1	1,250	0.30	0.40	Concrete lining
Branch feeder canal No. 2	600	0.30	0.30	Concrete lining
Branch feeder canal No. 3	1,550	0.30	0.35	concrete lining
Feeder canal (11 nos.)	4,000	0.30	0.30	Earth canal

Related structures			
in Main feeder canal	Offtake	:	2 nos.
	Check	:	2 nos.
	Culvert	:	9 nos.
in Branch feeder canal	Offtake	:	12 nos.
	Check	:	12 nos.
	Culvert	:	18 nos.
in Feeder canal	Check (plank)	:	101 nos.

(2) Drainage canals and related structures

The drainage system in the pilot farm comprises two (2) main collector drains, four (4) collector drains, 15 field drains and four (4) catch drains. The required structures related to the above canals would be drain inlets, drainage junctions, culverts, drops and cross drains.

The general features of the proposed drainage facilities are shown below:

(Unit: m)

Canal	Length	Bed Width	Canal Height
Main collector drain No. 1	1,050	0.50	1.20
Main collector drain No. 2	1,550	0.40	1.00
Collector drain No. 1	850	0.40	1.10
Collector drain No. 2	800	0.50	1.10
Collector drain No. 3	400	0.40	0.90
Collector drain No. 4	350	0.30	0.70
Field drain (15 nos.)	5,750	0.30	0.70
Catch drain No. 1 (Existing)	1,350	1.20	1.50
Catch drain No. 2 (Existing)	450	0.60	0.90
Catch drain No. 3	750	0.50	0.80
Catch drain No. 4	450	0.40	0.70

Related structures

in Drains in farm field	Drain inlet	:	4 nos.
	Drainage junction	:	19 nos.
	Culvert	:	17 nos.
	Drop	:	10 nos.
in Catch drain	Culvert	:	13 nos.
	Cross drain	:	2 nos.

(3) Roads and related structures

The proposed road network would consist of trunk road, farm road and on-farm road. The existing road C289, linking the national road B6 and the pilot farm, would be improved with the asphalt pavement so that this road would be the trunk road for the pilot farm. The other farm roads would be newly provided for effective agricultural activities.

The general features of the proposed roads are summarized as follows:

(Unit: m)

Road	Length	Total Width	Effective Width	Pavement
Trunk road	400	6.0	5.6	Asphalt
Trunk road (Existing part)	7,850	6.0	5.0	Asphalt
Farm road No. 1	3,150	6.0	5.0	Gravel
Farm road No. 2 (Existing)	1,050	6.0	5.0	Gravel
On-farm road (9 nos.)	4,500	5.0	4.4	Laterite

Related structures			
to Trunk road	Cross drain	:	4 nos.
to Farm road,	Farm approach	:	5 nos.
to On-farm road	Farm approach	:	34 nos.

The farm layout of the above facilities is shown in DRAWINGS.

(4) Buildings

The buildings required for the pilot farm would consist of two categories, i.e. the buildings for farm operation and the buildings for experiment and demonstration.

The breakdown of buildings is preliminary summarized as follows:

(i) Buildings for farm operation
(Total floor space: 3,000 m^2)

- Pilot farm main office
- Garage for vehicles
- Rice mill house
- Warehouse for fertilizer and pesticide
- Workshop
- Garage for agricultural machineries and O/M equipments
- Warehouse for equipments and tools

(ii) Buildings for experiment and demonstration
(Total floor space: 700 m^2)

- Laboratory and lecture hall
- Meteorological station office

The layout of area for the above buildings is shown in DRAWINGS.

(5) Utility facilities

(a) Electric power supply system

The electric power supply system for the pilot farm would be installed by connecting with the public electricity service line.

(b) Water supply system

The surface water to be conveyed through the branch feeder canal No. 3 would be used after treatment. Then, the water supply system would comprise the following:

- Water tunk
- Water treatment facilities
- Distribution pipes

(6) Machinery and equipment

For effective activities and smooth operation of the pilot farm, the following machineries and equipments would be required:

- Agricultural machineries
- Operation and maintenance equipments
- Vehicles
- Rice mill
- Workshop equipments
- Experimental and training equipments
- Meteorological and farm observation equipments

5. PRELIMINARY COST ESTIMATE

The cost of the pilot farm comprises the construction cost of farm facilities, buildings and utility facilities, the equipment cost, the engineering cost, the miscellaneous cost, and physical contingency. The total cost was roughly estimated to be Kshs. 65 million as shown below:

(Unit: Kshs.)

Item	Cost
1. Construction Cost	25,000
2. Machinery & Equipment Cost	33,000
3. Engineering Cost	2,500
4. Miscellaneous Cost	2,000
5. Physical Contingency	2,500
Total	65,000

For the above cost estimate, the following were taken into account:

(1) The cost was estimated on the basis of "Current construction cost" issued by the Ministry of Works and Housing in 1987 and the present market prices in Kenya.

(2) The construction works would be executed on the contract basis.

(3) The engineering cost was tentatively set at 10% of the construction cost.

(4) The physical contingency related to the work quantities was set at 10% of the construction cost.

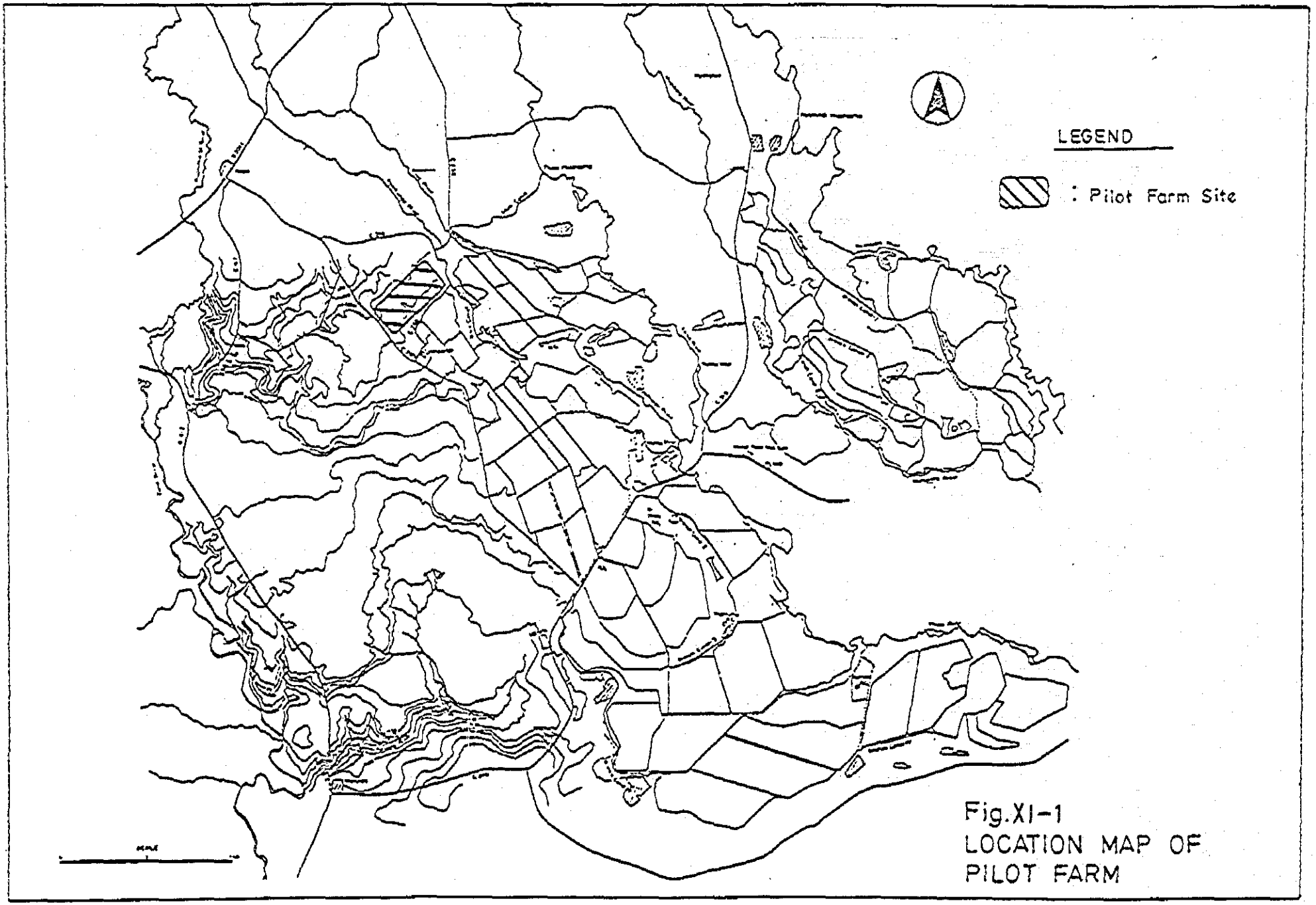

Fig.XI-1
LOCATION MAP OF
PILOT FARM

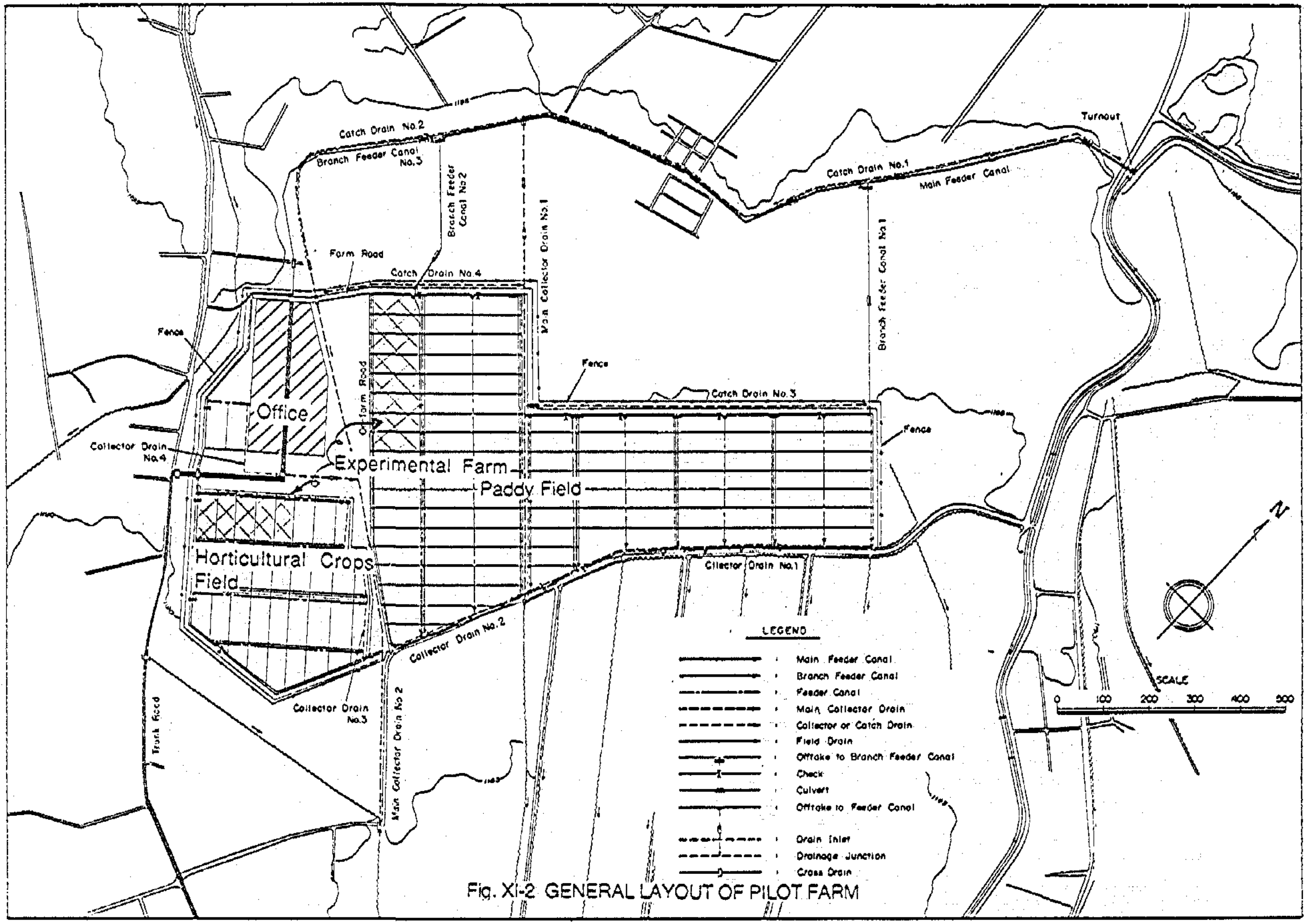

Fig. XI-2 GENERAL LAYOUT OF PILOT FARM